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The Relationship Between Socioeconomic Status and Blood Pressure

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ABSTRACT This paper examines the literature surrounding the relationship between blood pressure/hypertension and income. In addition, it examines blood pressure data in order to identify potential relationships between hypertension and income, race, and education. In reviewing the literature, the overall profile of the relationship between income and blood pressure in the United States is negative. However, there are some interesting nuances to this relationship that are discussed based on race and gender. Moreover, when looking abroad, evidence shows that the relationship between blood pressure and income can vary greatly depending on context. In looking at data from a youth sample (mean age = 15, 53.3% female, 35% African American, 38% Latino, 36% European American, 11% Asian American, 1% American Indian, and 16% multi-racial) a negative relationship between parental education and diastolic blood pressure was found. In contrast, evidence was found for a relationship between family income and blood pressure. These findings suggest that the relation between income and blood pressure does not emerge until adolescence.

INTRODUCTION

The Income-Blood Pressure Relationship

US Based Studies: Hypertension presents a serious public health concern and is associated with heart attack and heart failure, metabolic syndrome, stroke, and kidney failure with high blood pressure being responsible for 7.6 million deaths across the globe per year (Arima, Barzi, & Chalmers, 2011; CDC, 2020; Mayo Clinic, 2021). Income is a social determinant of health which is expected to explain disparities in hypertension and related outcomes. Seven studies of the relation between income and hypertension based on US samples found a negative relationship between income (or a related variable) and hypertension (or a related variable) (Appel et al., 2002; Bell et al., 2004; Kennedy et al., 2007,

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Leigh & Du, 2012, Lee & Levy, 2011, Rutledge et al., 2003; Sweet et al., 2013). The relationship between income and socioeconomic status (SES) and hypertension in the United States seems to be straightforward: increasing income decreases one's risk of developing hypertension, however there are some nuances to this relationship. This review adds to the literature by synthesizing the findings of numerous researchers and exploring the income-hypertension relationship in depth amongst specific groups and contexts.

The relationship between income and hypertension has been measured several different ways with consistent findings for the negative relationship between two variables. For example, SES (as measured by income) has been shown to be negatively correlated with hypertension across all races in the United States (Bell et al., 2004). In another study, the high-income group had significantly better controlled or normal blood pressure (BP levels) and less uncontrolled BP than the low-income group (Lee & Levy, 2011). This suggests that not only do individuals with higher incomes tend to have lower risk of having high blood pressure, but they tend to manage their high blood pressures better. It has also been found that there is a graded decrease in hypertension and heart disease reports as SES (calculated by taking into account age, gender, race, income and education) goes up (Kennedy et al., 2007). In other words, it was significantly more likely that someone with lower SES would report hypertension than someone with higher SES (Kennedy et al., 2007). This finding indicates that not only are more specific measures of income such as wages negatively correlated with hypertension in the U.S., but so too are broader measures of SES. It has also been shown that low-income individuals are significantly more likely to be at risk for Coronary Artery Disease (CAD), and that there were significantly higher hypertension history rates among low-income individuals (Rutledge et al., 2003). In all of these studies the findings indicate that higher income is associated with reduced risk of hypertension in the United States.

The Role of Race in the U.S.

African American Women

Both Black men and women are at significantly higher risk of developing hypertension than other races in the United States. In 2017, 34.5% of White men and 32.3% of White women were living with hypertension as opposed to 45% and 46.3% of Black men and women respectively Benjamin et al., 2018). While overall income is negatively associated with hypertension in the U.S., this relationship is more pronounced in African American women. For instance, the strength of the negative correlation between SES (measured by income and education) and hypertension was stronger in Black women as compared to white women (Bell et al., 2004). This means that the gap between low-SES Black women and high-SES Black women with respect to hypertension was significantly higher than other racial groups. It is unclear why exactly this is the case as this was a correlational study, but it should be noted that irrespective of income, Black women had a higher likelihood of having hypertension compared to White women (Bell et al., 2004). Race should be viewed as a "risk marker" and not a "risk factor" as it is associated with but does not cause CVD-risk itself (Appel et al., 2002). Unexplained variance between these groups in hypertension and CVD prevalence could be due to social factors (such as systemic racism and discrimination against African Americans).

The Role of Gender in the U.S.

Is the Income/SES-Hypertension Relationship Stronger in Women?

The relationship between income and health is stronger in women than in men. In a U.S. based study looking at the relationship between wages and hypertension in 25–65-year-olds only higher income female participants had significantly better controlled or normal BP levels and less uncontrolled BP than the lower income female participants Leigh & Du (2012). This difference was not seen between males (Lee & Levy, 2011). Similar sex differences were found in a sample of middle-aged males and females (Leigh & Du, 2012). In combination these studies are indicative of a stronger relationship between wages and income and BP and BP control amongst women than men.

The Variability of the Income-Hypertension Relationship

Looking at non-U.S. based studies the results showed how based on context the income-hypertension relationship can change significantly. In a study conducted in Ghana, a positive relationship between wealth and hypertension amongst adults was demonstrated (Addo et al., 2009). A similar finding was demonstrated in a study conducted in China amongst a rural sample—a positive correlation was found between individual equivalized income and hypertension and community income and hypertension (Chen & Meltzer, 2008). No associations were found in this study between income and hypertension among the urban sample (Chen & Meltzer, 2008). These findings starkly contrast with the U.S. based findings of negative correlations between income in health as it suggests that amongst these samples as wealth increased so too did the likelihood of having hypertension.

More research needs to be done to understand and interpret the reasons for these findings and for their contrast with U.S. findings. However, it is clear that the nature of this relationship is not static and can change depending on the context within which it is being examined. In this case, one possible explanation is the difference in country-level income as Ghana and China are middle income and upper-middle income countries respectively, whereas the U.S. is a high-income country. Another possible factor is the difference between urban and rural settings (Chen & Metlzer, 2008).

More evidence of the variability of the income-hypertension relationship comes from Canada. One study found that the income-hypertension relationship can change based on gender, race and sexuality. For instance, while increased income reduced hypertension risk in women, it raised the risk in men (Veenstra, 2013). This relationship was the same for Black Canadians but with a stronger relationship for Black men. Moreover, these relationships reversed completely for South Asian Canadian men and women (Veenstra, 2013). Furthermore, there was a strong positive relationship amongst bisexual participants hypertension risk and income, and a weak negative one for heterosexual participants (Veenstra, 2013). These findings indicate how the context that may influence the income-hypertension relationship is not limited to broader environmental factors such as country-level income and urban versus rural setting, but can also include individual differences such as sexuality, race, and gender.

In another study, a possible explanation for how this relationship can differ so substantially based on factors such as race and gender was demonstrated (Bell et al., 2004). Mexican American women showed a weaker relationship between hypertension and SES as compared to women of other races. Among Mexican American women, those with higher SES had more alcohol use, smoking, and physical activity and less physical activity (Bell et al., 2004). Therefore, the increased drinking and smoking likelihood with higher SES conflicted with the reduced obesity and increased physical exercise. This explains in part how improving SES can have both good and bad associations that might contribute to conflicting effects on hypertension risk.

The Absolute and Relative Income Hypothesis

An important distinction made by researchers in this field is between the absolute income hypothesis and the relative income hypothesis. The former proposes that income and health are related such that one's health is related only to the value of one's own income, whereas the latter proposes that the incomes of others play a role. The assumption of the absolute income hypothesis is that health is tied to the material goods and services that are needed to afford a comfortable life, whereas relative income takes into account the potential stress and harm of being lower on the income spectrum compared to someone higher up (regardless if both have enough to live comfortably) (Kawachi et al., 2002).

In a study that took place in Denmark looking at hypertensive control (a measure of how well one's hypertension is being managed) and its relationship with SES participants less than 65 yrs old with more education had better control of hypertension whereas less education meant worse control. Despite there being free and equal access to healthcare in Denmark, socioeconomic status

still appears to be related to blood pressure control which supports the relative income hypothesis. More evidence in support of the relative income hypothesis comes from a study based in Hong Kong looking at adolescents. Hong Kong has "highly accessible and affordable health care, free universal education, strong family ties and a social safety net" (Kwok et al., 2015). It was found that higher relative household income deprivation meant higher diastolic blood pressure and lower relative household income rank also meant higher diastolic blood pressure (Kwok et al., 2015). In other words, both measures for relative household income (how much a household earns compared to others) were negatively correlated with diastolic blood pressure. However, there were no relationships between blood pressures and any of the absolute income measures (Kwok et al., 2015). This suggests that it was how much a given household was earning with respect to other households in the neighborhood and not simply the amount of income alone that was important in defining this relationship.

Current Study

The purpose of the current study is to examine the impact of parental education and family income on blood pressure in a diverse sample of early adolescents.

METHODS

Participants: A total of 379 participants were recruited from a total of three schools. Two hundred and twenty-eight census tracts, 23 crime districts, and 148 police beats were represented across the participants. The mean age of participants was 15. The sample was approximately 53.3% female, 14.4% low-income (family income less than $25,000 per year), 35% African American, 38% Latino, 36% European American,11% Asian American, 1% American Indian, and 16% Multi-racial.

Variables: In examining the relationship between socioeconomic status and health, the role of race, income, and education were all looked at with respect to diastolic and systolic blood pressure, and BMI was also controlled for in data analyses.

Race**:** Participants self-reported on their race according to the following categories: Black or African American, Asian or Asian American, Native American, White or European American, Mixed (multi-ethnic), and "other."

Income: Family income was broken down into the following categories: $0-$25,000, $25,001-$50,000, $50,001-$80,000, $80,001-$100,000, $100,001-$150,000, and $150,000 and over.

Education: The Hollingshead measure of socioeconomic status was used (Hollingshead, 1975. The traditional Hollingshead measure is graded on a 7-point scale as follows:

7 = graduate/professional training
6 = standard college or university graduation
5 = partial college, at least one year of specialized training
4 = high school graduate
3 = partial high school, 10th or 11th grade
2 = junior high school, including 9th grade
1 = less than 7th grade
0 = not applicable or unknown

However, in this study in order to simplify data collection and analysis, scores that would normally be scored as 1, 2, or 3 were scored as a "1 = did not finish high school." This was then coded as "3 = partial high school" because 10th or 11th grade is the most common time for students to drop out of school. As such, participants' scores ranged from 3 to 7. Pairwise analysis revealed a significant difference in blood pressure between those that scored "4" and those that scored "7." In other words, those that finished high school, but did not do any college or more schooling differed significantly with respect to diastolic BP such that those with more schooling head lower BP.

BMI: Body mass index % scores were formed based on self-reported height and weight as reported by participants.

Blood pressure: Diastolic blood pressure (indicates the blood pressure of an individual when the heart is beating) and systolic blood pressure (indicates blood pressure of an individual during the rests between each heartbeat) was measured by researchers during a stress task.

RESULTS

In a one-way ANOVA, statistically significant differences emerged between participants from different education levels for diastolic BP F (4, 113) = 3.80, p=.01. This finding remained significant even when the impact of BMI was included in the analysis as a co-variate F (4, 109) = 2.92, p = .03). There was no significant relationship between systolic blood pressure and the Hollingshead measure of education F (4, 113) = 2.43 p = .052.

There were no significant relationships indicated by one-way ANOVAs for income and systolic blood pressure F (5, 110) = 1.12, p = .35, or income and diastolic blood pressure
F (5, 110) = 1.41, p = .23.

There were also no significant relationships between race and systolic blood pressure F (6, 101) = 1.12, p = .36, or race and diastolic blood pressure F (6, 101) = 1.36, p = .24.

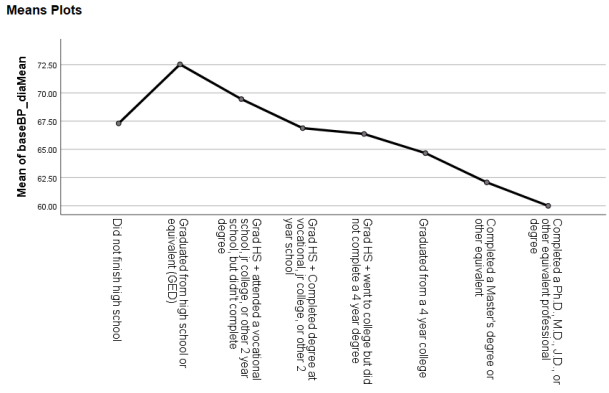

Fig 1. Diastolic blood pressure with respect to parental education level.

DISCUSSION

The impact of education, income, and race on blood pressure were examined controlling for BMI. The current study hypothesized that income would have the strongest relationship with blood pressure, but this was not the case. The results showed that education seemed to have the most robust relationship with blood pressure such that higher levels of education corresponded with lower diastolic blood pressure. In one-way analysis, education showed a statistically different level between group means based on education with respect to diastolic BP even after accounting for BMI. Interestingly, neither of the one-way ANOVAs for race and blood pressure demonstrated significant differences between groups. This finding starkly contradicts the literature reviewed from adult samples.

Interesting patterns emerged with education. Specifically, looking at pairwise comparisons, it was the case that those that scored a 4 on the Hollingshead measure were significantly different with respect to mean diastolic BP than those that scored a 7. This significance of this is that those who scored a 4 were high school graduates, and those who scored a 7 were individuals who had gone on to graduate school and received professional training. It is peculiar that a similar finding was not found between the no high school group and the graduate school group as one would expect completing a high school degree to be helpful for one's health. Nevertheless, this is a correlation study and so we cannot prove causation here, moreover this may be an artifact. The downward trend of blood pressure based on education and the significant difference between a very low educated group and an extremely high educated group remains striking. One interesting interpretation of this finding is that graduate school in and of itself seems to be related to significantly lower blood pressure than not attending any college and that this means that graduate school is related to lower diastolic blood pressure. In other words, there is something special about the correlation between a great deal of schooling and benefits for one's diastolic blood pressure. However, the truth is likely more nuanced as even though there are not significant pairwise differences between each step up in education with respect to diastolic

blood pressure, the graph displays a continual lowering of blood pressure as one goes up the education ladder. Perhaps with more research we could learn whether there are continual additive benefits of education on one's diastolic blood pressure, for instance, is it the case that this is a graded relationship? Or, perhaps more research could uncover that there is something unique about graduate schooling and its correlation with lower diastolic blood pressure.

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